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Oregon Agricultural Experiment Station, in cooperation with the Bureau of Entomology, United States Department of Agriculture.

Pea-Weevil Control in the Willamette Valley

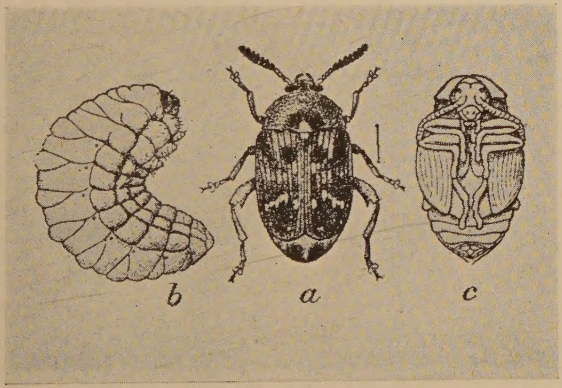

Figure 1. Pea-weevil: a, beetle; b, larva or grub; c, pupa. *(Enlarged.)*

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Pea-Weevil* Control in the Willamette Valley†

By

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In the Willamette Valley of Oregon the Austrian winter field pea has become a very important crop. The increase in acreage has been remarkable but along with it has come an alarming increase in the damage caused by the pea-weevil. The amount of pea-weevil infestation has not merely kept pace with the rapid extension in acreage but the actual infestation has been increasing over the whole area at such a rate that the pea-growing industry of Oregon is seriously threatened. In isolated fields where three successive crops of peas have been grown on the same ground, the third crop has been almost a total loss because of pea-weevil injury.

Unless the ravages of the weevil can be checked, the growing of this valuable cash crop will have to be abandoned in the Pacific Northwest. Part of the recommendations for the control of this serious pest, as given in this Circular, are a reversal of present practices and do not permit of the greatest utilization of the pea straw and stubble for fertilizer. There are no other known methods, however, of holding the weevil in check while further studies are being conducted. It is thought that it will be preferable to lose the fertilizing value of the straw than to give up the growing of peas and be forced to substitute a much less valuable crop. After the infestation has been materially reduced, it may be possible to keep the weevil in check without burning the straw and stubble every year.

Crop heavily infested. An examination of representative lots of peas of the 1930 crop shows the seriousness of the situation at the present time. Examinations of 32 lots of cleaned peas from the warehouses showed infestations. This by no means indicated the amount of infestation when the lots of peas were taken to the warehouses, however, because in the process of cleaning the peas the light ones—those which have been damaged most by the weevils—are blown out, leaving a very much smaller percentage of weevil-infested peas.

The amount of infestation was less in isolated fields growing the first crop of peas than it was in fields having previously grown one or more crops of peas or in those fields adjacent to other fields. An examination of the peas shattered in the field in 22 different plots showed infestations

**Mylabris pisorum* (L.); order, Coleoptera; family, Mylabridae.

†The information in this Circular is the result of one season's studies conducted in the sections of the Willamette Valley where Austrian winter field peas are grown. The data presented, therefore, are not complete but are offered as a working basis for further study of pea-weevil control. The writer is grateful for valuable assistance rendered by Dr. Don C. Mote, H. A. Schoth, H. L. Wagner, the Jenks-White Seed Company, and many others who have helped to make these studies possible.

varying from ¼ of 1 percent to 91 percent. The average of these infestations was 19 percent.

An examination of different kinds of peas grown in 57 experimental plots at the Oregon Experiment Station showed that the pea-weevil infestation ranged from 27 to 96 percent, with an average of 71 percent.

The pea-weevil has only one generation each year. The adult pea-weevil is a small grayish or brownish gray beetle about one-fifth inch long and marked with black and white spots. There are four distinct stages in the life cycle of the pea-weevil—the egg, the larva, the pupa, and the adult. The adult female lays its eggs on the partly developed pea pods. The eggs are reported to require from two to three weeks to hatch, depending on the weather conditions. The actual time in Oregon has not as yet been determined. The duration of the larval and pupal stages also varies according to the temperature, but some of the pupae are ready to transform to adults soon after the peas are ripe. Development is most rapid during hot weather; hence at the harvest season only a short time is required for the weevils to change from larvae to adults. Agitating the peas in the process of harvesting and cleaning causes many of these weevils to emerge. Other adult weevils may emerge during any warm period even until after planting time the next spring. The weevils that emerge in the fall seek shelter and hibernate. As far as has been observed, the adults do not feed in the fall except to take small quantities of moisture; but after coming out of hibernation in the spring, they feed on pollen in the flowers and may even eat small portions of the leaves and petals. The injury caused by the feeding of the adults, however, is inconsequential when compared with the injury caused by the larvae. Although several larvae may enter one pea, only one larva lives to maturity, eating out most of the food material in the pea and leaving only a little of the cotyledons surrounding the big larval burrow.

Peas form the sources of infestation. Because of the fact that the pea-weevil has only one generation each year, the idea has become prevalent that the seed peas that are planted form the principal source of infestation. Where fumigated seed has been planted and the resulting crop becomes weevil infested, the infestation is explained by saying that the fumigation was not thorough or that a neighbor failed to fumigate his seed. Careful investigation has shown that the planted pea seeds form an almost negligible source of weevil infestation. There are, however, three sources of weevil infestation, all of which are important. These are: (1) garden peas that are allowed to ripen in large or small plots, most of which are not harvested and fumigated or destroyed before the pea-weevils have emerged; (2) peas and pea screenings in public and private warehouses; and (3) the peas that are shattered out and left on the field at harvest, including those left in the straw stacks by stationary threshing machines.

In isolated fields of Austrian winter peas the first infestation has been traced to the garden pea as the source of the pea-weevil. The writer has frequently found garden peas in gardens weeks after the peas became ripe. This practice gives the weevils an opportunity to mature and fly away. Occasionally, enough peas are gathered for seed for the next year's crop. These pea seeds are stored away without having been fumigated to kill the contained pea-weevils. That the garden pea is a *serious* source of

infestation is shown by the results of the investigation of many gardens in various parts of the Valley. In no garden examined was there less than 22 percent infestation. Usually the infestation is much higher. In one such garden, where all the peas in 100 pods were examined, 325 peas contained weevils and only 69 were free from weevils.

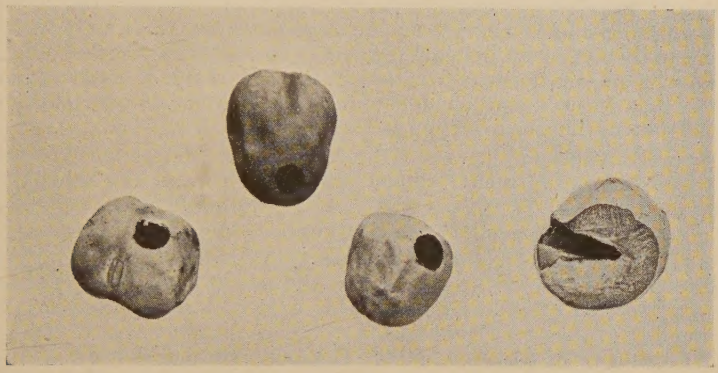

Figure 2. Garden peas showing exit hole and cavity made by the pea-weevil. (*Enlarged.*)

In pea-growing sections, such as parts of the Willamette Valley, the second-named source of infestation—namely, peas and pea screenings in public and private warehouses—becomes serious. After the peas are harvested they are taken to the warehouse, where they are stored until they can be cleaned. During this time the emerging weevils are coming out of the sacks and flying away. The cleaning process removes most of the weevily peas along with the screenings. The general practice is to fumigate the cleaned peas before they are put on the market, but the screenings containing most of the weevils are not usually fumigated. These are left standing around for days or weeks before being disposed of. Sometimes the screenings are stored in granaries or other buildings about the farm. All during the fall the contained weevils are emerging and seeking winter shelter.

On a warm afternoon late in the harvest season or early in September the adult weevils about the pea cleaners and piles of sacked pea screenings become as numerous as bees in an apiary. These weevils go into hibernation and come out to infest the next year's crop of peas.

The present practice of fumigating only the cleaned peas kills but a small number of the weevils produced in the crop. The large number of weevils left in the screenings under present practices are liberated to infest the next year's crop. That immense numbers of weevils are left in the screenings and only a small percentage in the cleaned seed is shown by repeated observation and may be thus illustrated. There are approximately 4,500 average Austrian winter field peas to a pound. A 100-pound sack of peas, therefore, contains at least 450,000 pea seeds. If 20 percent of the peas were infested, there would be 90,000 weevils to the sack. If four-fifths, or 80 percent, of the weevily peas are removed in cleaning, there remains but one-fifth in the marketable product. Under the present practice, only the marketable product is fumigated. In other words, the 80 percent of

weevily peas in the screenings are left in the warehouses or returned to the farms, where the weevils emerge and seek shelter for the winter.

The third source of weevil infestation—peas left shattered on the ground or unharvested at harvest time as well as those left in straw stacks—seems to have been quite generally overlooked in the past. In order to determine the relative importance of this source of infestation, plots 10 feet by 10 feet in size were measured in different fields and all of the peas found thereon were picked up and counted. From the information thus obtained the number of peas left per acre was computed. After the percentage of weevily peas was determined, the approximate number of weevils per acre was computed. This information is presented in Tables I-III.

The estimated number of peas left in the field after harvest ranges from 500,000 to more than 3,000,000 and the number of pea-weevils from 1,500 to more than 1,000,000 per acre. On one 40-acre field it was estimated that there were approximately 47,000,000 weevils to go into hibernation.

At first the plots were selected from fields which had been harvested by different methods, but it was soon found that the number of shattered peas was not the same in different fields harvested by the same method. The number of shattered peas was more nearly proportional to the yield, but the quantity of peas left on the field also depends largely upon the harvesting crews. It soon became apparent that all fields were not infested equally; hence isolated fields were sought for making counts.

Infestation increases each year. In isolated fields the percentage of infestation increased directly with the number of crops produced. That the pea-weevils fly from field to field was shown by the fact that the percentage of weevil infestation in adjoining fields was reasonably uniform whether the fields had produced the same number of crops of peas or not. Tables I, II, and III show the percentages of infestation in more or less isolated fields which had produced one, two, and three crops of peas respectively. These tables show a very decided increase in amount of weevil infestation each year. In Table I the high percentage, 10 percent, was found in a field of 4 acres several miles from other peas except small patches of garden peas; and the low percentage, ¼ of 1 percent, was found in a 100-acre field about 5 miles from where field peas had previously been grown.

The weevil population in fields that had produced two successive crops of peas, shown in Table II, ranges from 14 percent to 31 percent of the peas left in the field. It is evident that the weevils are increasing, for the lower percentage of infestation is higher than the highest infestation in Table I, while the highest in Table II is about three times as high as the highest in Table I.

Table III shows the results of examination of only two fields. The one having 77 percent infestation was a field of 12 acres about 8 miles from other crops of peas. In this field there was no known source for the increased infestation except the peas left on the ground during the two preceding autumns.

In the other field, with an infestation of 91 percent, screenings as well as peas left on the ground were the source of the heavy infestation. This 40-acre field showed more than 1,000,000 weevil-infested peas per acre left on the ground besides those left in the straw stacks by the stationary threshing-machine. The owner said that he had produced good crops all

three years. This third crop was all weevily, and he said he was through growing peas there until a way was found to control the weevils.

A yearly increase of weevil infestation as experienced by these two growers and, to a lesser degree, by all the growers in the Valley corresponds to the experience of the pea growers of Canada as reported by Fletcher,* who showed that the percentage of weevily peas had increased from less than 10 percent to practically 90 percent in a period of six or seven years and in 1902 estimated that during the preceding ten years the loss attributable to the work of the pea-weevil would fall not far short of one million dollars annually in one province.

TABLE I. 1930 PEA-WEEVIL POPULATION IN FIELDS AFTER ONLY ONE CROP OF PEAS HAD BEEN PRODUCED

Estimates from counts made on 100 square feet.

Number of peas found	Percent weevily	Estimated number of peas per acre	Estimated number of weevils per acre
	%		
2,585	1	1,126,026	11,260
2,033	6	885,575	53,134
3,269	2	1,422,976	28,459
4,539	8	1,977,188	158,175
5,628	7	2,451,556	171,609
1,377	.25	599,821	1,500
7,720	6.5	3,362,832	218,584
5,053	10.5	2,201,087	231,114

TABLE II. 1930 PEA-WEEVIL POPULATION IN FIELDS AFTER TWO SUCCESSIVE CROPS OF PEAS HAD BEEN PRODUCED

Estimates from counts made on 100 square feet.

Number of peas found	Percent weevily	Estimated number of peas per acre	Estimated number of weevils per acre
	%		
1,278	22.5	555,617	125,014
4,932	31.0	2,148,379	665,997
1,651	30.5	719,176	219,348
4,553	14.5	1,974,575	285,313
6,656	27.0	2,899,354	782,725

TABLE III. 1930 PEA-WEEVIL POPULATION IN FIELDS AFTER THREE SUCCESSIVE CROPS OF PEAS HAD BEEN PRODUCED

Estimates from counts made on 100 square feet.

Number of peas found	Percent weevily	Estimated number of peas per acre	Estimated number of weevils per acre
	%		
1,685	77.0	733,986	564,509
2,932	91.5	1,277,179	1,168,619

As long as such great numbers of peas are left on the field at harvest, some means must be adopted whereby these peas can be destroyed or otherwise disposed of to prevent the weevils from reaching maturity and

*James Fletcher—Report of the Experimental Farms (Canada) for 1902, 1903. 1903, pp. 169-201.

escaping. The weevils in the peas on the warm ground in the fields complete their development and come out to hibernate before most of the weevils in sacks in storage are fully developed. One plot examined September 17 showed that 339 weevils had emerged, while only 22 live weevils remained in the peas. This early emergence makes it necessary to combat them immediately after harvest.

Where the stubble and straw left on the field are sufficiently heavy to burn, as they are in most fields where the harvesting has been done with a combine harvester and thresher or with a pick-up machine, burning of the stubble promises to prove an effective method of destroying the weevils contained in the peas. In order to determine the efficiency of fire as a means of killing the weevils contained in the peas on the ground, the writer burned measured plots of 100 square feet in several fields and collected all remaining peas and dissected them to find out the effect on the weevils. Where the straw and stubble were heavy, most of the peas were burned to ashes or were completely charred through; but where there was only a medium heavy layer of straw, only a few peas were completely burned up although all were charred on one side or heated sufficiently to kill the contained weevils. Where the straw was light, just enough to burn, the peas were scorched on one side and heated through sufficiently to give a very satisfactory kill. Out of ten plots burned and carefully examined, the three following are the only ones where any living weevils were found. From a plot covered with a medium heavy layer of straw, 3,489 peas were recovered. These contained 1 living and 123 dead weevils. From a plot having a very light covering of straw, 753 peas were recovered. They contained 2 living and 271 dead weevils. From another plot having a medium heavy covering, 1,939 peas were recoverd. They contained 3 living and 1,109 dead weevils. The peas containing the living weevils had undoubtedly fallen into cracks in the ground or had been crushed into the cleat tracks of the tractor. In each of these three plots, however, more than 99 percent of the weevils had been killed. In all the other plots 100 percent of the weevils had been killed. As a result of the favorable showing made by these burned plots, several fields were burned by their owners and the writer made examinations of the peas after the fire. Where the fire had actually passed over the ground, no living weevils were found within the peas; but on small spots missed by the fire, there were living weevils within the peas.

Control. Any effort to control the weevil must take into consideration all three sources of weevil infestation. In the past the attention has been focused on the pea seeds which were planted. This did not control the pea-weevils in any section where peas were grown extensively. Proper handling, however, of the peas grown in gardens, the peas and pea screenings at the warehouses or storage rooms, and the peas that are lost and left on the ground at harvest will assure a practical and, at the same time, an economical control.

Although some of the recommendations made in this Circular are a reversal of present practices, their adoption will make it possible to continue to grow crops of peas until other methods can be worked out. On the other hand, a continuation of present practices will mean that commercial pea growing will have to be discontinued as it has been in other sections.

For years farmers have been advised to turn under straw on their land rather than burn it. This has applied particularly to pea straw because of its high value as a fertilizer. Careful burning immediately after harvest will destroy this fertilizer. It will, however, insure the possibility of continuing the production of this valuable cash crop, provided the garden peas and the entire harvest crop are properly handled.

Garden peas should be cared for early. There are sufficient plots of garden peas left in the fall to insure a thorough distribution of the pea-weevils in the adjoining fields. In the control of the weevil, therefore, the proper care of such plots is important. Peas that are being raised for seed should be gathered as soon as they are ripe and should be fumigated immediately. Early fumigation not only kills the weevils but insures a better grade of seed peas by preventing the weevils from devouring such a great portion of the interior of the peas. If the garden peas are not being kept for seed peas but are remaining because they are too old or too weevily to be eaten green, they should be destroyed before they ripen. The vines should be gathered and fed to livestock or otherwise destroyed, giving no chance for the contained weevils to complete their development and emerge.

Entire crop should be fumigated. The field peas under present practices are allowed to remain in the field unharvested and unthreshed from three to five weeks longer than they should be. During this time the pea-weevils are developing rapidly within the peas. When the crop is finally taken to the cleaner, a large percentage of the weevily peas have become so light that they blow out with the screenings, thus reducing the salable portion of the crop. While the main crop is fumigated, the screenings containing most of the weevils are not fumigated. *The whole crop should be fumigated immediately after harvest and before it is cleaned.* This would do away with the possibility of weevil infestation from the screenings, as well as from unfumigated peas standing around waiting to be cleaned. Construction of larger fumigators at the public warehouses where the peas are cleaned would be necessary.

Harvesting. Because of the rapid development of the weevils in the peas in the hot summer weather, the crop should be harvested as early as possible. This will make it necessary to plant the peas alone or with early-maturing crops. It will necessitate planting only such acreages as can be harvested quickly. If the peas are harvested with combines or with pickup threshing-machines as good threshing jobs can be done as with stationary threshing machines. At the same time, the straw will be scattered over the stubble so that it will be possible to burn over the fields to destroy the weevils in peas remaining in the fields.

Burning the fields. On hot afternoons during the dry weather of August the stubble burns very readily. In fact, great care must be taken to prevent the spread of fire. A permit to burn should be obtained before burning is undertaken. This done, several furrows should be plowed around the outside of the field.

A satisfactory method for firing the stubble is to fill and wrap an old automobile tire with old burlap or other old rags, then saturate it with oil to insure a good blaze. While it is burning, drag it around the field behind

an automobile with 15 to 20 feet of tie wire. If the wind is blowing, care must be taken so that the fire will not be driven with the wind and catch the automobile on the opposite side of the field. A thorough burn is essential to destroy the weevils. Because the weevils develop so rapidly within the peas on the warm ground, burning should be done immediately after harvest so that the minimum number of weevils will have escaped.

Fumigation. Fumigation is the most satisfactory and successful way to kill the weevils in the newly harvested crop. It is inexpensive and if done properly kills all stages of the weevils in or among the peas without injuring the peas either for seed or for food. The fumigant to be used depends, to a great extent, upon the quantity to be fumigated and the facilities available for fumigation.

Chloropicrin. Chloropicrin has proved to be a very satisfactory fumigant for peas on a commercial scale. As it is very tenacious and irritating to the mucous membrane, it can be used satisfactorily only where there are good facilities for ventilating the fumigatorium.

Hydrocyanic-acid gas. For large quantities of peas, hydrocyanic-acid gas is a very satisfactory fumigant. As it is a deadly poison to man and animals, proper arrangements must be made for ventilating the fumigation chamber and it should be used only by reliable persons who are thoroughly informed on the subject of fumigation.

Carbon disulfide. There is no known fumigant which can be used with greater ease or simplicity and with a greater assurance of satisfactory results than carbon disulfide. Because of its low cost, the thoroughness of its work, and the simplicity of its application, it is especially adapted for use on the farm where only small lots of peas are to be fumigated. It is equally satisfactory for large lots. A metal garbage can with a tight lid or a barrel which can be tightly covered makes a good fumigating chamber for small quantities of peas. After the peas are in the can or barrel, an ounce or two of carbon disulfide can be poured over the seeds and the lid closed tightly. The seeds should be aired out after 24 to 48 hours. As the carbon disulfide gas is inflammable when mixed with air in certain proportions, it is necessary that lighted matches or cigars, or other fire, be kept away from it. Even electric sparks may ignite the gas.

Recommendations.

1. Harvest the peas early with combines or with pick-up machines. Take care to allow as little waste as possible.
2. Fumigate the whole crop immediately after threshing and before it is cleaned.
3. Until better methods are worked out, obtain burning permit and burn the straw on the stubble in order to destroy the weevils left in the peas on the field. Obviously such burning calls for exercise of due care to prevent spread of fire beyond the area to be burned.
4. Harvest all garden peas early and fumigate or destroy them to prevent the escape of weevils.
5. Cooperation of all pea growers is essential in carrying out the foregoing recommendations. Those who do not cooperate will furnish weevils for their own crops as well as for those of their neighbors.